

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Robert L. Goldsmith Paper No.:

Serial No.: 10/698,267 Examiner: Menon, Krishnan S.

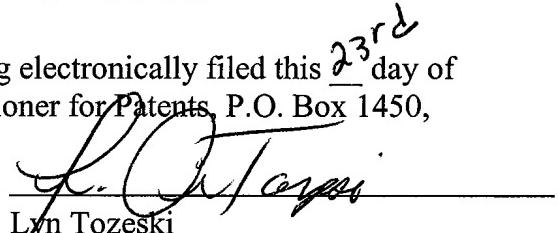
Filed: 10/31/2003 Group No.: 1723

For: Membrane Devices for Docket No.: 19642-00023
Pervaporation, Gas Separations,
and Perstraction With Permeate and
Sweep Fluid Conduit and Method of Use

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF ELECTRONIC FILING

I hereby certify that this Declaration is being electronically filed this 23rd day of April, 2007, and goes to Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.


Lyn Tozeski

DECLARATION OF ROBERT L. GOLDSMITH UNDER 37 CFR 1.132

Robert L. Goldsmith declares as follows:

1. I am a named inventor in the subject application. I have a PhD in chemical engineering granted from the Massachusetts Institute of Technology in 1966. I have worked in the field of ceramic membrane devices for the last 20 years. Due to my education, long experience, and patents in the field (including patents 4,983,423; 5,009,781; 5,106,502; 5,108,601; 5,114,581; 5,120,576; 5,221,484; 5,879,715; 6,126,833; 6,695,967; and 6,767,455), I believe that I am an expert in the field of ceramic membranes and their uses.
2. I have reviewed the January 25, 2007 Office Action, about which I have the following comments.

3. Commercialization of the Membrane Monolith Structure of US Patent 4,781,831:

It is relevant to present an overview of the commercial history of monolith membrane devices made under this prior art patent, as it shows the knowledge of this technology has been widespread in the field of ceramic membrane filters.

- CeraMem Separations, Inc., began selling devices of the structure disclosed in the '831 patent ca. 1993. About 20 commercial installations were made, throughout the world (US, several European countries, Japan, India, etc.) The equity in CeraMem Separations was sold to Corning, Inc. in 1997, and CeraMem Separations ceased selling the products then. Product literature for the CeraMem Separations, Inc. products (published prior to 1998 when all sales ceased), and a photograph of the products, are attached as Exhibit A. The Exhibit A product literature was widely distributed throughout the world between 1993 and 1998. I was an officer or director of CeraMem Separations during this entire time period.
- Corning, Inc. Sales of products covered by the '831 patent by Corning, Inc. began shortly after 1997 under the Trademark "Cercor". Product literature of Cercor (dated 1999), which was widely distributed, is attached as Exhibit B. Sales were made for over forty installations.
- CeraMem Corporation began selling a new version of products made under the '831 patent in 2002. An undated prior art product bulletin that was distributed in commerce beginning around 2002 is attached as Exhibit C. First commercial sales occurred in 2003, and about 25 commercial installations have been made. A photograph of one of these ceramic membrane devices is attached as Exhibit D. I have been an officer or director of CeraMem Corporation during this entire period.
- NGK Insulators, Ltd began selling a product under the '831 patent ca. 2000, and definitely by 2002. CeraMem Corporation has royalty reports showing sales in 2002. A prior art, publicly-distributed announcement of NGK's product is attached as Exhibit E. A photograph of the NGK product is also attached as Exhibit F.

Hence, membrane modules of the structure disclosed in US Patent 4,781,831 have been sold commercially for at least 14 years by four separate corporate entities.

4. Examples of Patents For Membrane Modules with Sweep Fluid

The following patents, as examples, show the early recognition of the benefits of use of a sweep fluid in a membrane module to facilitate the removal of a gas or vapor phase permeate.

- US Patent 4,834,779: Process for membrane separation of gas mixtures (filed 1986, issued 1989)
- US Patent 5,096,584: Spiral-wound membrane separation device with feed and permeate/sweep fluid flow control (filed 1990)
- US Patent 5,169,530: Hollow fiber module using fluid flow control baffles (filed 1989)
- US Patent 5,298,669: Perstraction sweep stream for a membrane reactor (filed 1993)
- US Patent 5,464,540: Pervaporation by countercurrent condensable sweep (filed 1993)
- US Patent 5,430,224: Supercritical perstraction process (filed 1995)
- US Patent 6,517,725: Oil dehydrator (filed 2001)

These patents show the recognized need for using a sweep fluid in pervaporation and other processes with a gas-phase permeate; such need has been recognized since at least the 1986 filing date of the 4,834,779 patent.

5. Previously Sold Pervaporation Units Suitable for Use with Sweep Fluid

Sulzer ChemTech previously sold pervaporation modules with individual membrane tubes enclosed in stainless steel tubes. The annular space was suitable for circulation of a sweep fluid. A photograph of this product is attached as Exhibit G. The product has been withdrawn from the market due to premature membrane failures.

It is to be noted that the individual sleeves for each pervaporation membrane are used to provide circulation of a heat transfer fluid to provide the required heat of vaporization, generally to remove water from solvents. The heat of vaporization of the water is quite high, and if not supplied, the temperature of the feed material drops and correspondingly the pervaporation rate.

A major limitation of the Sulzer pervaporation module was the cost of this construction, required for such heat transfer. Recognizing this limitation and being intimate with the construction of the modules described in the 4,781,831 patent, my concept in the present application of using the permeate conduits within a high surface area monolith membrane device for circulation of a heat transfer medium arose. As large monolith membrane modules provide a much lower cost device, the importance of doing this is apparent. Based on my experience, CeraMem sells its membrane modules (or projects costs once in full production) for about $\frac{1}{4}$ to $\frac{1}{2}$ the price of other prior art ceramic membrane modules used for the same applications. A pervaporation application of immediate commercial interest is the removal of water from ethanol (e.g., fuel ethanol) to bypass the azeotrope at about 95% ethanol to produce high purity ethanol.

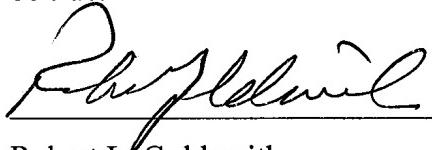
The ability to circulate a heat transfer fluid is not the only potential use of my invention. A diluent can also be circulated to reduce the permeate side partial pressure(s) of a permeating component(s) for a variety of membrane applications, such as pervaporation, perstraction and gas separations.

6. Conclusions relevant to the obviousness of combining a monolith membrane device containing permeate conduits with permeate sweep fluid circulation:

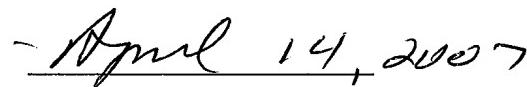
- Modules of the structure of 4,781,831 have been on the market commercially for 14 yrs. Knowledge of the existence of such membrane modules is widespread and known throughout the membrane industry.
- Devices for using permeate sweep fluid have been in the patent art for at least 18 yrs.
- The fact that monolith membranes with permeate conduits were disclosed by me in 4,781,831 (1988), and the means and benefits of the use of a sweep fluid have been known for 18 yrs, indicates that the combination is not obvious to one of ordinary skill in the art. No one has done this, to the best of my knowledge, until the present patent application was filed.
- The inventive methodology can accomplish separations at substantially lower cost than methodologies employing prior art modules.
- These conclusions are especially relevant as I, as the inventor of the primary application (4,781,831), am clearly “skilled in the art” and did not make this

connection myself until ca. 15 years after making the application for USP 4,781,831. During this period, I was active and fully employed in the membrane field, managing the development of ceramic membranes and membrane processes at CeraMem Corporation (the assignee of the present application) and the chairman of the board of CeraMem Separations, Inc. I remained active in the membrane field art – patent applications, published technical literature, attendance at industry conferences, presenter of papers at technical conferences, and an author of numerous technical papers and reports on Government sponsored research programs in the field.

The undersigned declares that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon. All statements made of the declarant's own knowledge are true and that all statements made on information and belief are believed to be true.



Robert L. Goldsmith



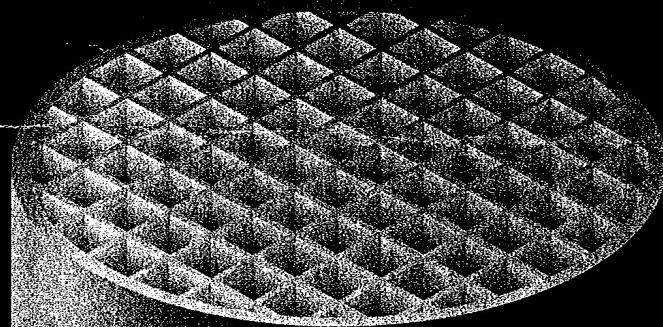
Date

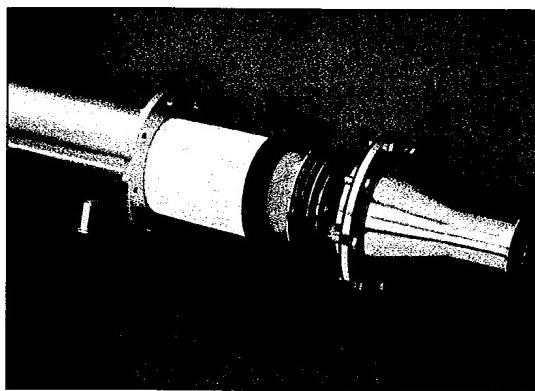
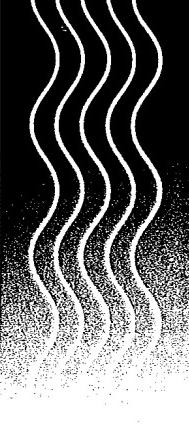
Exhibit A

CeraMem

S E P A R A T I O N S

Ceramic Membrane Filters



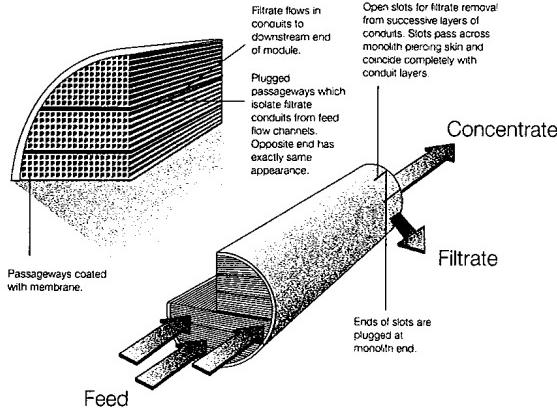


Housing/filter assembly.

LIQUID FILTRATION PRODUCTS

CeraMem manufactures and sells crossflow membrane filters with pore sizes in the Ultrafiltration (UF) and Microfiltration (MF) ranges.

CeraMem purchases ceramic monoliths from Corning Incorporated. These monoliths contain a large number of 2 mm or 4 mm square parallel passageways extending from one face to the other. CeraMem modifies the monolith support by converting some of the passageways to filtrate conduits. Ceramic membrane coatings are then applied to the remaining monolith passageways. One or more membrane layers are applied and sintered to form a strongly bonded ceramic membrane with a stable, controlled pore size. These membranes have FDA clearance for contact with food.



Monolith membrane module with filtrate conduits.

CeraMem sells complete assemblies consisting of the ceramic filter modules mounted in housings. These housings are offered in either a 3-A approved sanitary stainless steel design or a less expensive, non-sanitary

industrial design. In both cases, the ceramic filter is fitted with elastomeric "boots" that fit over each of the two faces of the filter. These boots seal the permeate space to prevent contamination by the feed/concentrate.

CeraMem ceramic membrane filters for liquid separation are:

Rugged

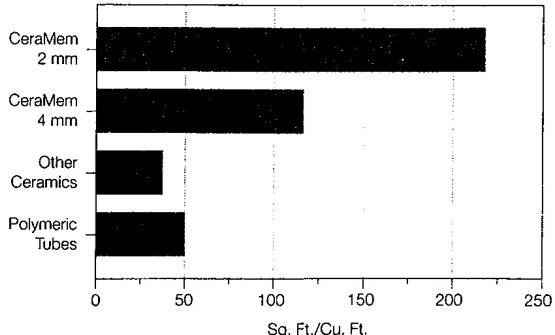
They can withstand high operating temperatures and are unaffected by oxidants, organic or hydrocarbon solvents, harsh cleaning chemicals and steam. CeraMem filters are useable in the 3-12 pH range. They can be backpulsed and backflushed to extend time between cleanings.

These features make them ideally suited for demanding applications such as clarifying organic process streams, reclaiming solvents, treating wastewaters containing solvents, recovering energy by recycling hot streams, and treating streams having high viscosities at ambient temperatures.

Compact

With their very high packing density (membrane area/module volume), CeraMem filters allow you to use fewer membrane modules, resulting in lower capital and operating costs for less piping, valving and pumping capacity.

Compactness of CeraMem Liquid Filters vs. Alternatives

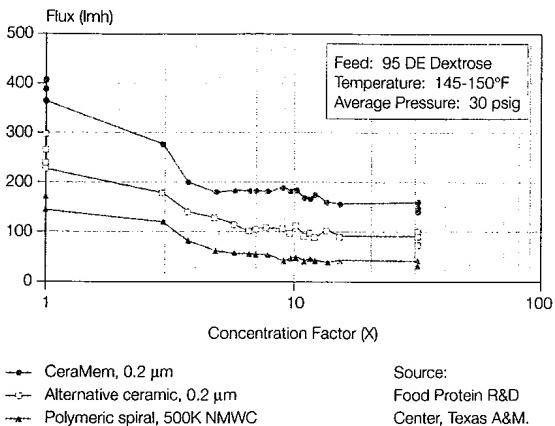


High Performance

CeraMem modules have low hold-up volumes for both feed and filtrate, minimizing losses of valuable or time-sensitive fluids within the module or housing assembly.

In many applications, the proprietary chemistries of CeraMem's membranes result in higher productivity (flux) than competitive membranes. The example shown here is for dextrose clarification.

Clarification of Dextrose Derived from Hydrolysis of Corn Starch Performance of Competing Membranes



Cost Effective

The combination of low initial cost per square foot of membrane area, lower systems and operating costs due to compactness, higher performance and long membrane lifetimes means CeraMem membrane systems are less expensive to install and operate than many polymeric systems.

L I Q U I D F I L T R A T I O N

A P P L I C A T I O N S

CeraMem ceramic membrane crossflow filtration products are used by the food and beverage, petroleum, chemical and petrochemical industries, as well as wastewater treatment facilities to clarify, separate and decontaminate liquids. Below is a partial list of application examples.

Replacement of Conventional Dead-ended Filtration

CeraMem filters eliminate the costs of purchase, handling, disposal and product losses associated with diatomaceous earth filtration. Microfiltration with CeraMem filters often allows recycle of streams or higher value alternative dispositions than traditional filter aids.



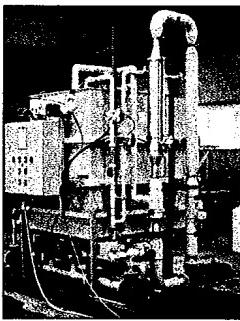
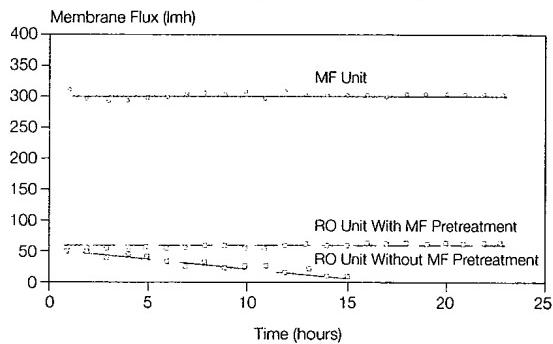
MF system
operating upstream
of RO on dairy
condensate.

CeraMem filters have successfully replaced dead-ended filtration in juice clarification, dextrose and sucrose clarification and catalyst haze removal from edible oils, among other applications.

Filtration Upstream of Reverse Osmosis

CeraMem ultrafiltration membranes, installed upstream of reverse osmosis units, can remove components that would quickly foul reverse osmosis membranes.

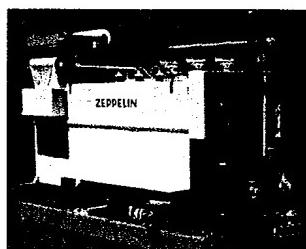
Evaporator Condensate Treatment by Reverse Osmosis (RO) With and Without Pretreatment by Microfiltration (MF)



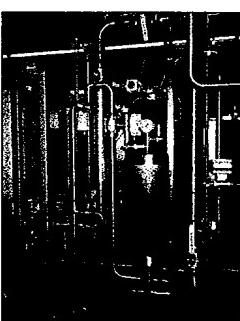
System operating
on industrial
laundry waste.

Cleaning and Recycling Industrial Laundry Waste

CeraMem ultrafiltration membranes allow industrial laundries to clean hot effluents for water recycling. Because of their high temperature tolerance, these ceramic filters can be used in very hot liquid streams, saving chemical and energy costs during the recycling process.



System cleaning
vehicle wash water.



Pilot system for
clarification of
ethanol stillage.

Oil Removal from Wastewater Streams

CeraMem's ultrafiltration membranes will concentrate oily water emulsions, permeating the clean water for discharging or recycling and recovering an oily concentrate for disposal or recycling.

CeraMem

SEPARATIONS

Let us help
you meet your
liquid and gas
filtration needs
with our
advanced line
of ceramic
membrane
filters.

For additional
information,
please contact
us at:

CeraMem
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02154
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Fax
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Ceramic Membrane Filters

CeraMem Separations Incorporated manufactures and markets patented ceramic membrane products for environmental and process applications. Its membrane filters were first marketed in 1991 and are used worldwide to clarify, separate, and decontaminate liquids, and to remove particulate matter from exhaust-gas emissions.

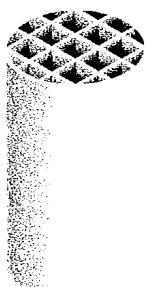
The company is headquartered in Waltham, Massachusetts and maintains a sales office in London, and sales agents in Düsseldorf, Liège, Madrid, Tokyo and Seoul.

CeraMem Separations, Inc. is a joint venture of CeraMem Corporation, Exxon Corporation (through its wholly-owned subsidiary, Enjay Inc.) and Corning Incorporated.

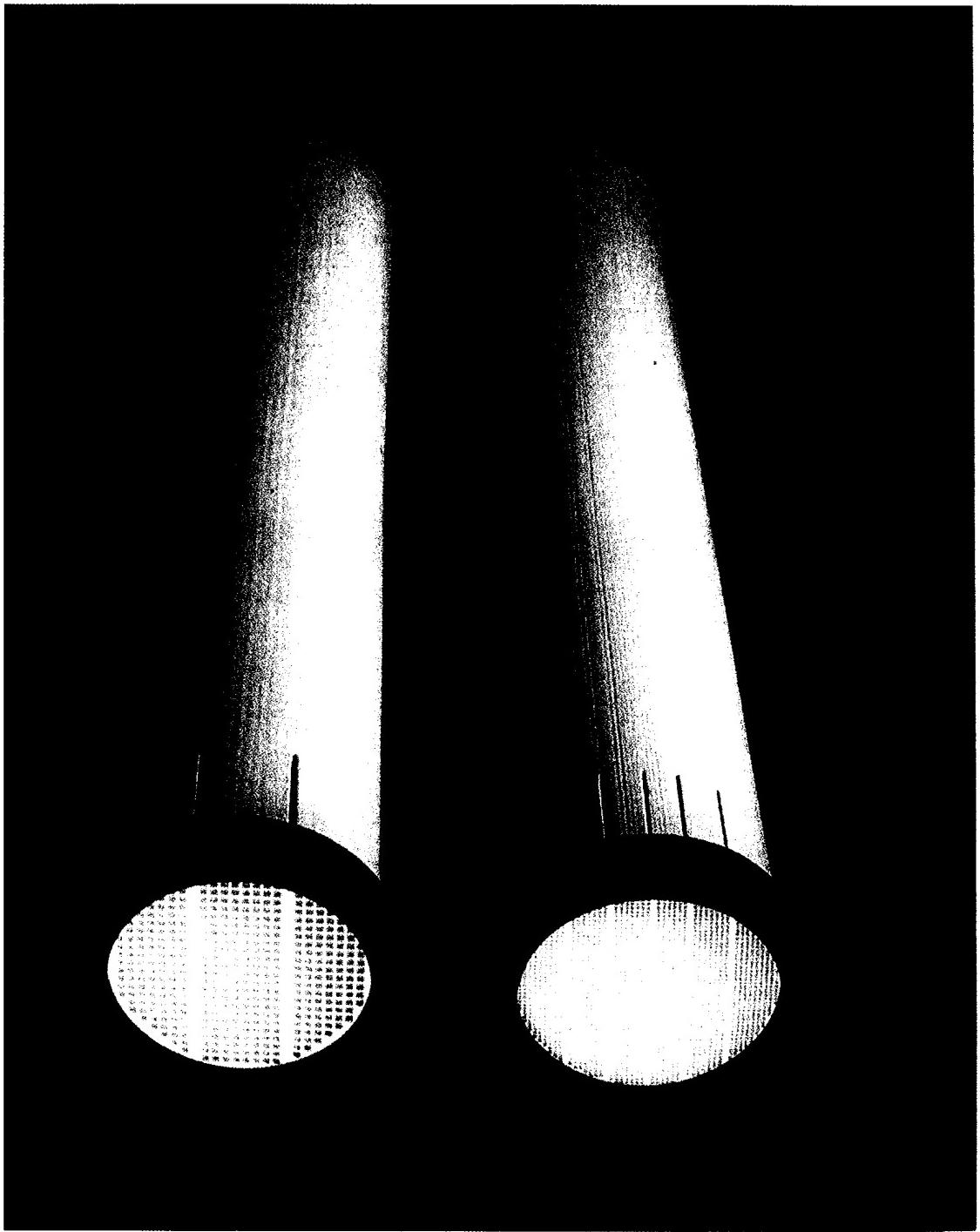
CeraMem Corporation was founded in 1986 to undertake technical development of proprietary ceramic membranes and is a continuing source of potential new ceramic membrane technologies for CeraMem Separations.

Corning Incorporated provides CeraMem Separations with a secure supply of the honeycomb ceramic monoliths that CeraMem coats to make its products.

Exxon provides access to the potentially large petroleum and petrochemical markets for CeraMem's rugged, heat- and hydrocarbon-resistant membranes.

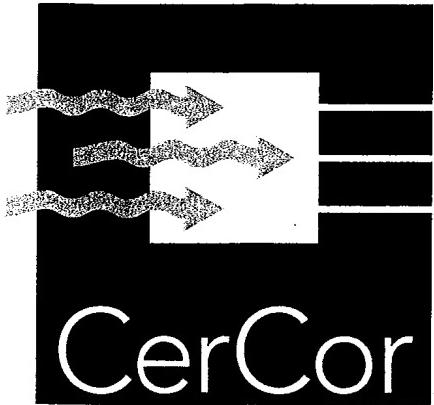


CeraMem Filters —
Advanced Technology
for Advanced Solutions



Photograph of CeraMem Separations, Inc. Membranes 144 mm diameter x 864 mm length

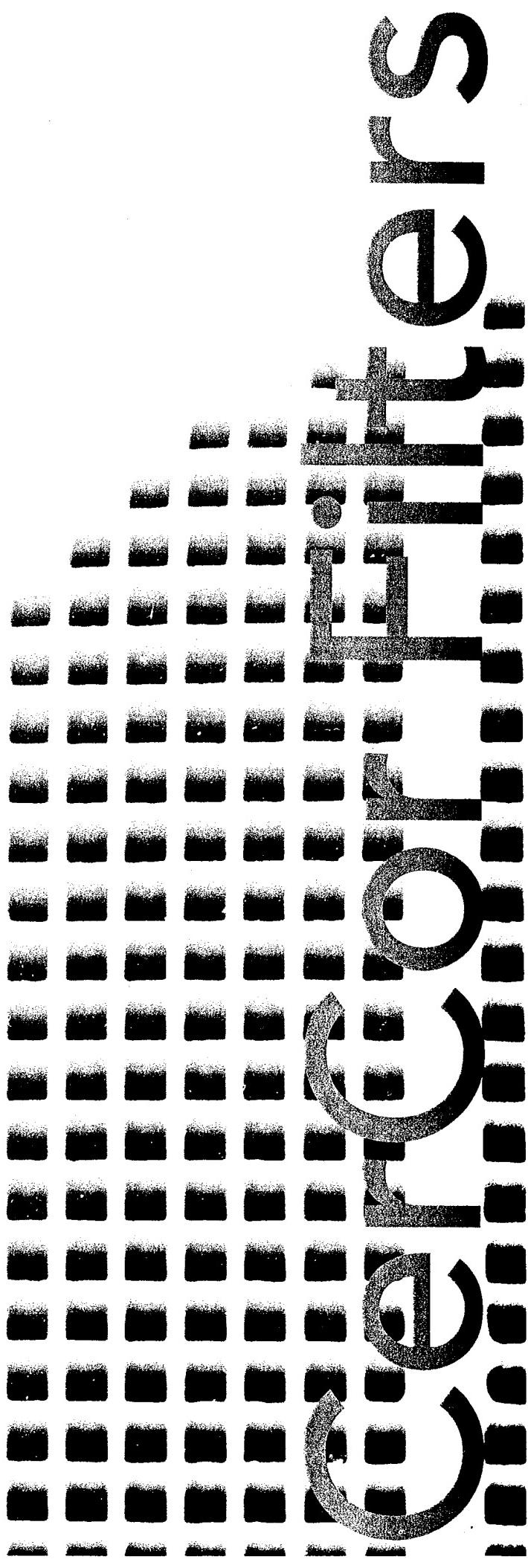
Exhibit B



SEPARATIONS

Ceramic
Membrane
Crossflow
Filters for
Liquid
Filtration

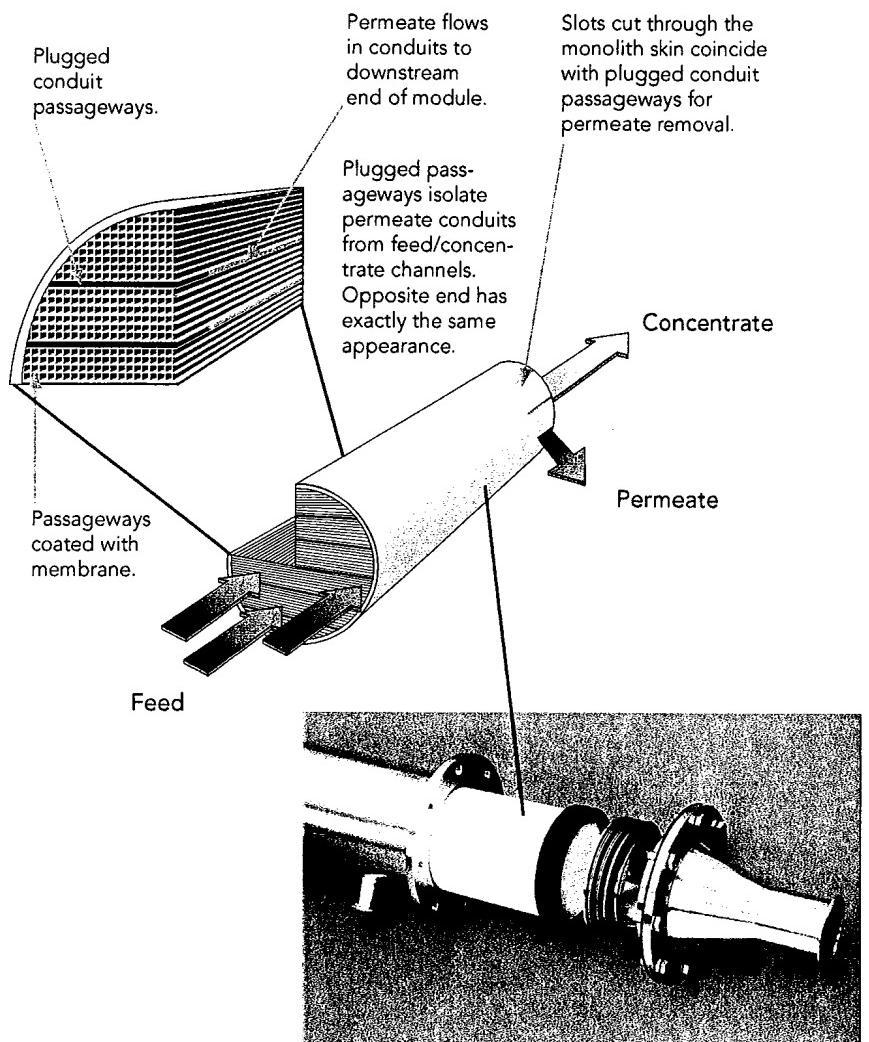
CORNING



Liquid Crossflow Filters

CerCor Separations manufacturers and sells crossflow membrane filters with pore sizes in the Microfiltration (MF) and Ultrafiltration (UF) ranges.

These filters contain a large number of approximately 2mm square parallel passageways extending from one face to the other. A CerCor patented approach modifies the monolith support by converting some of the passageways to permeate conduits. This enables the entire filter diameter to be effectively utilized.



Ceramic membrane coatings are then applied to the remaining monolith passageways. One or more membrane layers are applied and sintered to form a strongly bonded ceramic membrane with a stable, controlled pore size. These membranes have FDA clearance for contact with food.

CerCor sells complete filter assemblies consisting of the ceramic filter elements mounted in housings. These housings are offered as either a 3-A approved sanitary stainless steel design, or a less expensive, non-sanitary industrial design. In both cases, the ceramic filter is fitted with elastomeric "boots" that fit over each of the two faces of the filter. These boots seal the permeate space to prevent contamination by the feed/concentrate.

CerCor ceramic membrane crossflow filters for liquid separation are:

Rugged

They can withstand high operating temperatures and are unaffected by oxidants, organic or hydrocarbon solvents and steam. CerCor filters are usable in the 2-13 pH range. They can be backpulsed and backflushed to extend time between cleanings.

These features make them ideally suited for demanding applications such as clarifying organic process streams, reclaiming solvents, treating wastewaters containing solvents and recovering energy by recycling hot streams.

CerCor
SEPARATIONS

Compact

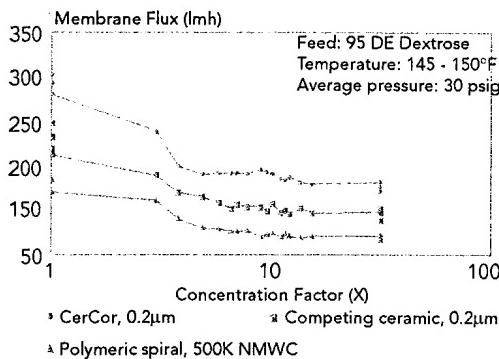
With their very high packing density (membrane area/module volume), CerCor filters allow you to use fewer membrane modules. This results in lower capital and operating costs as a result of decreased piping, valving and pumping requirements.

High Performance

CerCor filter assemblies have low hold-up volumes for both feed and permeate, minimizing losses of valuable or time-sensitive fluids within the filter assembly.

In many applications, the proprietary chemistries of CerCor's membranes result in higher productivity (flux) than competitive membranes. The example shown here is for dextrose clarification

Clarification of Dextrose Derived from Hydrolysis of Corn Starch Performance of Competing Membranes



CerCor ceramic membrane cross-flow filtration products are used by the food and beverage industries, as well as wastewater treatment facilities to clarify, separate and decontaminate liquids.

Cost Effective

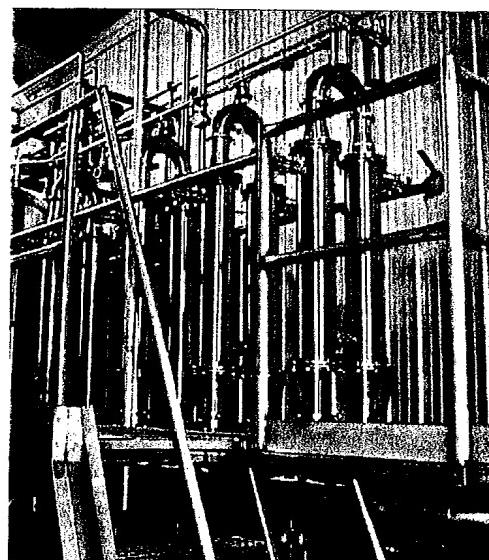
The combination of low initial cost per square foot of membrane area, lower system and operating cost due to compactness and higher performance, make CerCor membrane systems less expensive to install and operate than alternative ceramic and many polymeric systems.

Liquid Filter Applications

Juice Clarification & Filtration

CerCor microfiltration membranes are used in juice clarification applications removing suspended solids without stripping color. Long term stable flux rates allow several days between required cleanings in many applications.

MF system for juice clarification and filtration



Oil Removal from Wastewater Streams

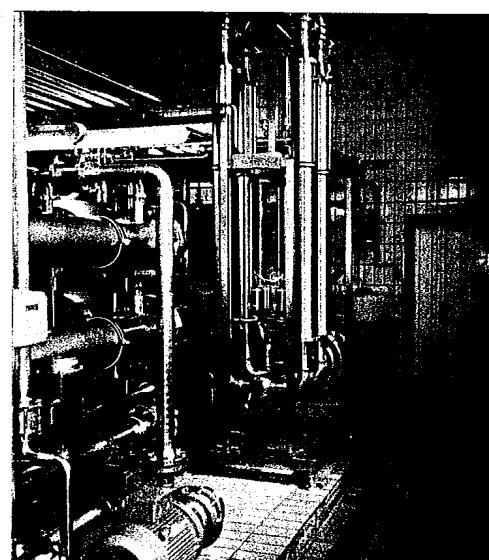
CerCor's ultrafiltration membranes will concentrate oily water emulsions. Clean water permeate is discharged, oily concentrate is collected for disposal or recycling.

Filtration Upstream of Reverse Osmosis

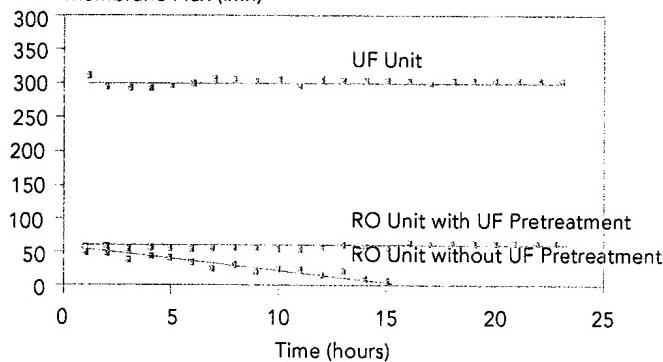
CerCor ultrafiltration membranes, installed upstream of reverse osmosis units, can remove components that would quickly foul reverse osmosis membranes.

Evaporator Condensate Treatment by Reverse Osmosis (RO) With and Without Pretreatment by Ultrafiltration (UF)

UF system operating upstream of RO on dairy condensate



Membrane Flux (l/mh)



CerCor Filters Advanced Technology for Advanced Solutions

CerCor Separations manufactures and markets patented ceramic membrane filter products for environmental and process applications. Its membrane filters were first marketed in 1991 and are used worldwide to remove particulate matter from gas and liquid streams.

The company is headquartered in Corning, NY.

For additional information, please contact us at:

CerCor Separations Business
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Fax: +49 611 7366-143
E-Mail: CIGermany@corning.com



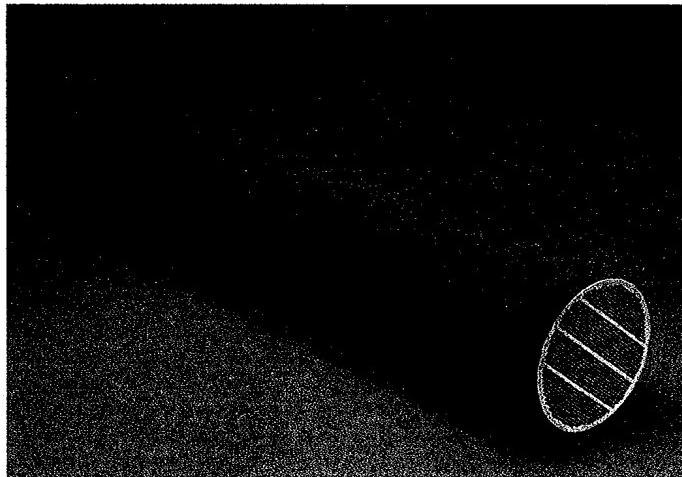
Exhibit C

New Generation Ceramic Membranes

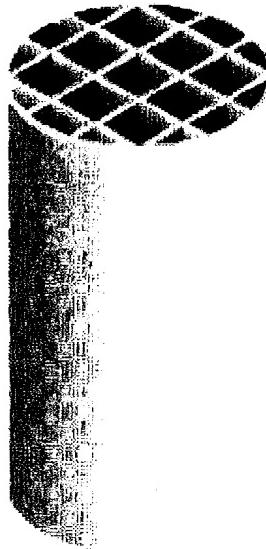
Production Scale Modules

This new generation of 'honeycomb' inorganic membrane modules for microfiltration and ultrafiltration has a variety of *abrasion-resistant* ceramic membranes applied to silicon carbide monolith supports. Product features include

- Compactness
- Low cost
- High temperature capability
- Chemical inertness



**Full Size Membrane Element with
115 ft² (10.7 m²) Membrane Area**



System with 42 Modules

Many industrial plants totaling tens of thousands of square feet of membrane have been sold in countries around the World using this patented technology in "first generation" CeraMem™ products. This "second generation" CeraMem membrane module incorporates new chemically inert membranes and support monoliths (silicon carbide) and features superior chemical and mechanical durability. The membrane elements are extremely compact with > 230 ft² membrane area/ft³ (> 760 m² membrane area/m³).

Production Scale Membrane Module Specifications

Membrane Elements

Membrane elements are 34 inches (864 mm) long and 5.6 inches (142 mm) in diameter. Membrane area is approximately 115 ft² (10.7 m²). Single monolith membrane elements with membrane area up to 410 ft² (38 m²) are planned.

Membrane pore sizes and chemistries available:

Product Code	Membrane Type	Water Flux (Typ.) , lmh/bar
PM-0200-A	0.2 µm - α-alumina MF	400
PM-0100-A	0.1 µm - α-alumina MF	350
PM-0010-T	300,000 MWCO - titania UF	250
PM-0005-S	50,000 MWCO - silica UF	200

Ongoing research at CeraMem is expected to result in the expansion of the product line to include nanofiltration, pervaporation, and gas separation membranes, all with inorganic membranes.

Operating Conditions:

Operating Parameter	Range
Maximum Temperature	130°C, dependent upon seals
Maximum Trans-Membrane Pressure	150 psi (10 bar)
pH Range (PM-0200/0010-A & PM-0010-T) (PM-0005-S)	2 - 13 2 - 9 ¹
Recommended Cross Flow Velocity	9 - 12 ft/sec (3-4 m/sec)
Volumetric Flow-Rate for 12 ft/sec	300 gpm (70 m ³ /hr) ²
Pressure Drop at 12 ft/sec	15 psi (1.2 Bar), H ₂ O @25°C.

¹ Highly hydrophilic, non-fouling membrane for non-alkaline service

² At 12 ft/sec crossflow velocity, corresponds to 0.023 theo. hp/ft² (at 3.7 m/s, 0.18 theo. kW/m²)

Applications Recommended:

Tests to date indicate that there is little restriction on the use of these membranes for any conventional application. These membranes may be used for many applications in the food, dairy, beverage, pharmaceutical, metal working and finishing and many other industries.

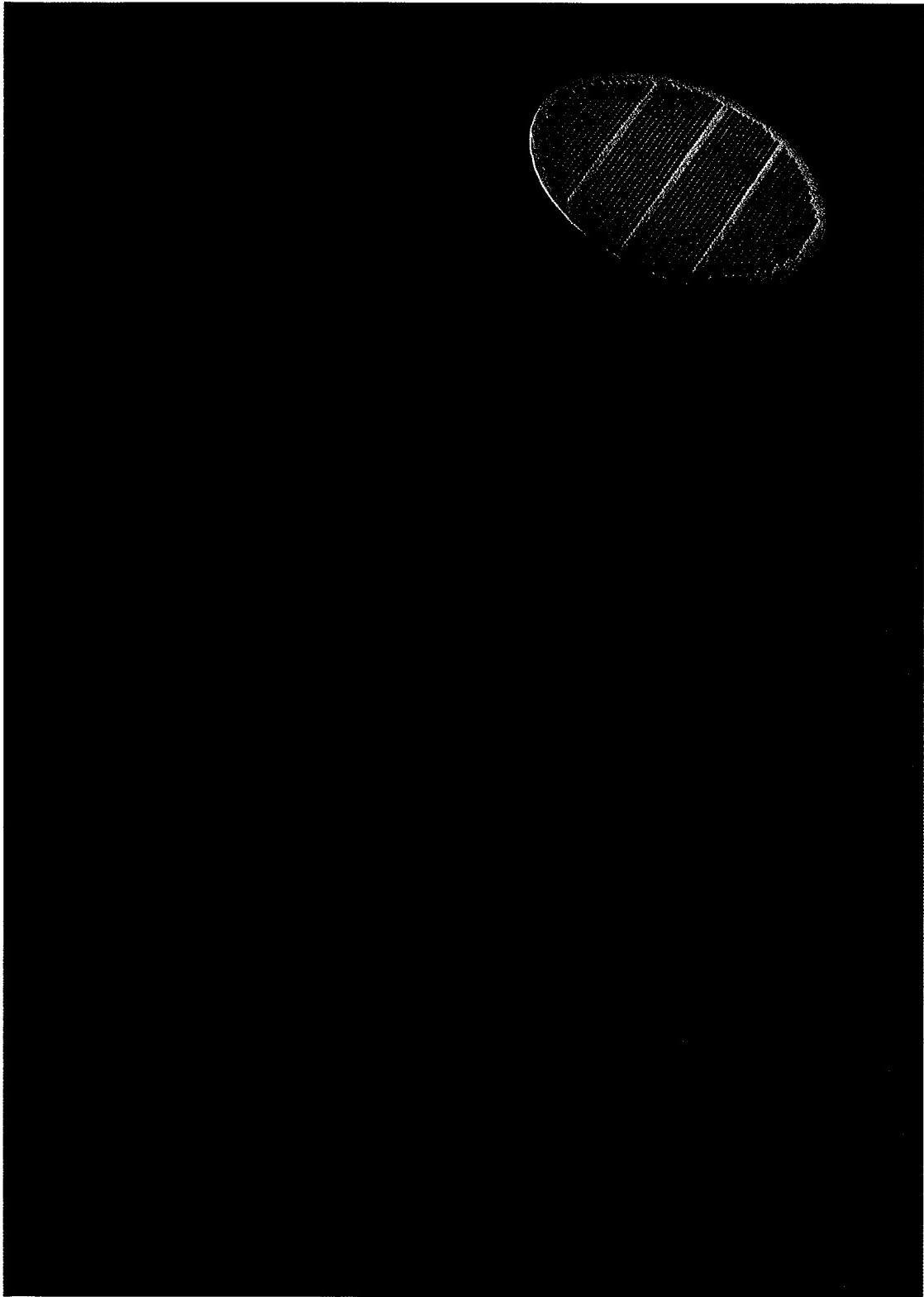
For additional information, contact:

CeraMem Corporation

12 Clematis Avenue, Waltham, MA 02453 www.ceramem.com

Tel. (781) 899-4495 Fax (781) 899-6478 Email sales@ceramem.com

Exhibit D



Photograph of CeraMem Corporation Membrane 144 mm diameter x 864 mm length

Exhibit E

NGK Expands Water Treatment Plant Business Through Large Ceramic-Membrane Water-Purification Systems

NGK INSULATORS, LTD. (President: Masaharu Shibata, Head Office: Nagoya, Japan) has developed a next-generation water-purification technology using large ceramic-membranes, and is enlarging its water treatment engineering business.

In the 1960's, NGK entered the water purification industry by offering ceramic filter underdrains for rapid filtration ponds. Since then, the company has been expanding its business as a specialized materials/equipment supplier. From 1989, the company started development of water purification systems using ceramic membranes, and from 1991 to 1993, participated in the "MAC 21 Project" - a project sponsored by Japan's Ministry of Health and Welfare for research and development of water purification systems using membranes. In 1996, NGK developed a commercial ceramic-membrane water-purification system for the first time in Japan, and has been selling these systems to small-scale purification facilities for public water systems.

Currently more than 96% of Japan is served by a public water supply, therefore development and introduction of new technology is increasing for the remodeling and renewal of these facilities. NGK newly developed the large ceramic-membrane water-purification system while targeting large savings in cost and space. The company plans marketing efforts to stimulate orders from middle- and large-scale purification plants, and is also supplying ceramic membrane units to water-related machinery and equipment manufacturers. Responding to the changing market, NGK will grow its businesses to establish a position as a major water treatment engineering company. In FY2005, the company aims at 10-billion yen in sales of water treatment facilities, primarily those utilizing the ceramic-membrane purification system.

NGK Ceramic Membrane Water Purification Systems

Monolithic and internal-pressure type ceramic-membrane elements of 180mm diameter, 1000mm length and 15m² membrane surface area are employed in the newly developed system. A goal of NGK's development of this new system is large savings of cost and space compared to conventional water purification facilities using ceramic-membrane elements of 30mm diameter and 1000mm length. Micro filtration through 0.1 micron size pores and highly porous ceramic membranes enable complete elimination of turbidity and impurities such as colloids and bacteria contained in raw water.

Characteristics of Ceramic Membrane Elements

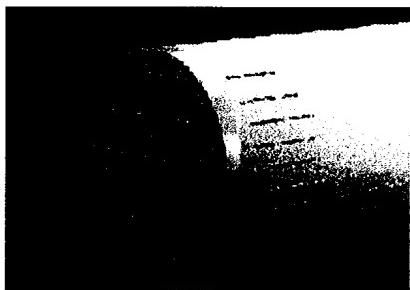
1. No chemical degradation and also no deterioration from heat and pressure enable longer operation.
2. Superior thermal/acid resistance and no dissolution of impurities.
3. High mechanical strength prevents damage to the membranes.

4. Superior chemical corrosion resistance allows easy recovery of membrane performance through chemical cleaning compared to polymeric membranes.
5. Used membranes can be recycled as ceramic material for other uses.

Characteristics of Ceramic Membrane Water Purification System

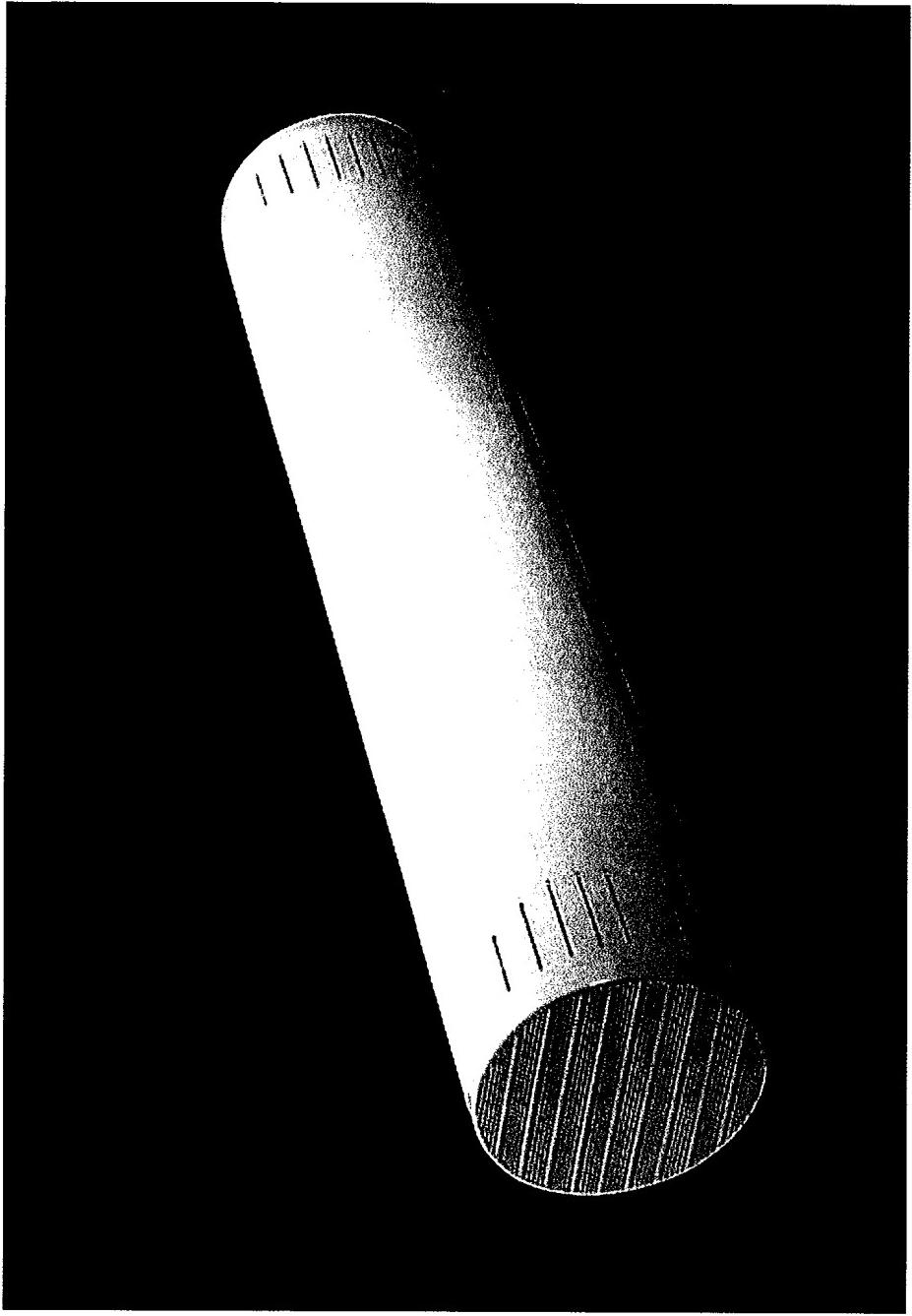
1. Enables stable treatment capacity for fluctuating raw water turbidity.
2. Pre- and mid-chlorination is unnecessary, so that generation of trihalomethanes is reduced.
3. Since sedimentation and rapid filtration ponds are not necessary, smaller construction space is possible.
4. Fully automated system, including backwash process, enables unattended operation.
5. Long-life ceramic membranes allow less-frequent replacement of membranes.
6. Dead end filtration enables high recovery rate of water (more than 98%).
7. Small running cost per filtration unit (below 10 yen/m³).
8. Automated treatment process allows simplified maintenance.

In July 2000, the large ceramic-membrane module received a certification by the Association of Membrane Separation Technology, and the large ceramic-membrane water-purification system was certified by the Japan Water Research Center in November 2000.



Ceramic membrane elements

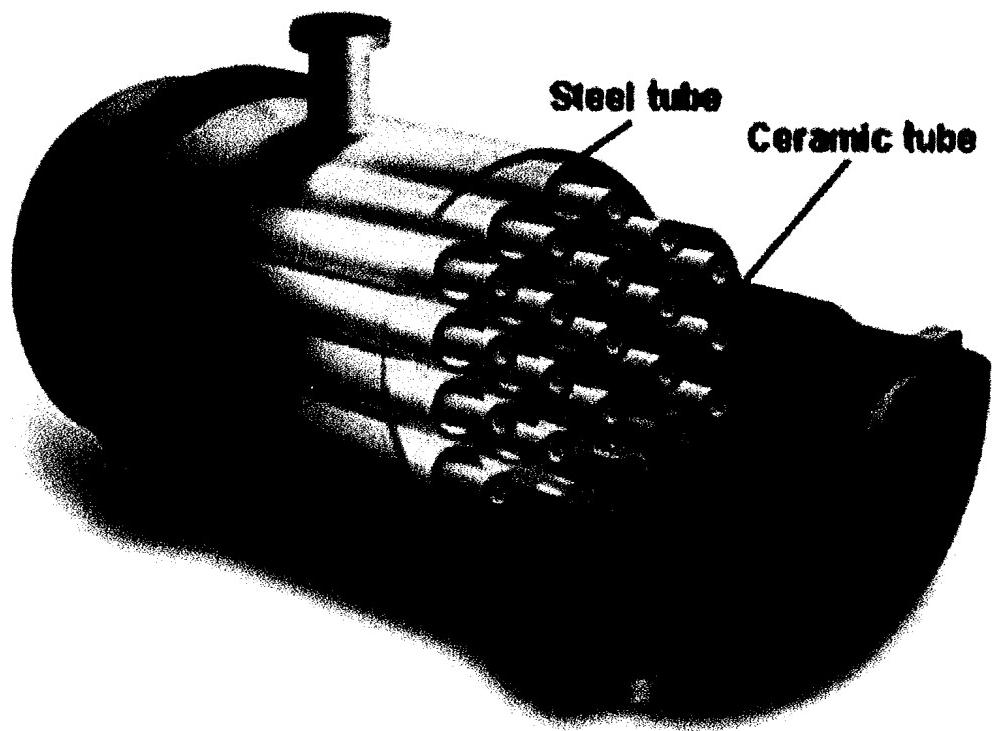
Exhibit F



NGK Insulators Ltd Membrane (2003), 180 mm diameter x 1000 mm length

<http://www.ngk.co.jp/english/news/2003/1014.html>

Exhibit G



Cutaway View of Discontinued Sulzer ChemTech Pervaporation Module